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Optical dot gain in a halftone print : Tone reproduction and image quality in the graphic arts

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Résumé / Abstract
The scattering of light within paper can affect the tone characteristics of a printed halftone image. A halftone image is formed by variation in the average reflectance, which is determined by the size of the ink dots. Photon migration within the paper from noninked to inked regions tends to increase the photon absorption and thus decrease the halftone reflectance-the dots are effectively larger than their physical size. This effect is known as optical dot gain or as the Yule-Nielson effect. The degree of optical dot gain depends on the distance that the photons migrate within the paper, which in turn depends on the paper's scattering and absorption characteristics, and on the thickness of the paper. We develop a theory that expresses the halftone reflectance in terms of the halftone microstructure-the screen period, dot size, dot shape, and ink transmission-and the effects due to the paper. The paper effects are represented in the theory by a point spread function, which is a conditional probability density that characterizes the photon migration within the paper, and by the paper's reflectance. We construct a model of photon transport within the paper by solving the transport equation using a diffusion approximation, from which we derive a point spread function. We interpret the expanded Murray-Davies model of halftone reflectance in terms of the theory developed here by giving a probabilistic interpretation to optical dot gain. We show that optical dot gain can be related to a single numerical parameter. Using the diffusion point spread function, we show how this parameter is related to the physical quantities that characterize the paper.

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